P803796/WO/1

Daimler Chrysler Inc.

Internal Combustion Engine with a Lubrication Circuit
And a Dampening Element

This invention involves an internal combustion engine for a motor vehicle with a lubricant pump to transport a fluid, almost incompressible lubricant, especially a motor oil, as well as a lubricant guide element to guide the lubricant to the lubrication points of the internal combustion engine.

It is the goal of the invention to make available an internal combustion engine for a motor vehicle in which pressure pulsations are dampened within a lubricant guide element and sound radiations are effectively reduced.

The goal is achieved by an internal combustion engine according to Claim 1. Advantageous variations and further developments of the invention are the objects of Sub-claims 2 to 9.

The internal combustion engine for a motor vehicle manifests a lubricant pump to transport a fluid, almost incompressible lubricant, especially a motor oil, as well as a lubricant guide element to guide a lubricant to the lubrication points of the internal combustion engine. According to the invention an elastic, flexible, dampening element to accept pressure

pulsations in the lubricant is associated with the lubrication guide element in the internal combustion engine. The dampening element preferably is a component part guiding the lubricant and thus is so coupled in the lubrication circuit that it is in direct contact with the lubricant. Natural or synthetic oils are preferably used as the lubricant. The dampening element manifests a flexibility in the lubrication circuit which preferably includes a dead water zone or a resonance area or a flexible wall. Pressure pulsations of the lubricant can thereby be reduced by friction and turbulence or, as the case may be, by specific discharge into the wall.

In the design of the invention the dampening element manifests an abrupt expansion of the line cross-section, especially in the manner of a bypass resonator, to form a calmed lubricant reservoir. A dead water zone is formed in the calmed lubricant reservoir in which pressure pulsations of the lubricants can be reduced. The expansion of the line cross-section can be designed in particular as a Helmholtz resonator across which specifically determined oscillation frequencies from the lubrication circuit can be sent.

In another variation of the invention the dampening element manifests a flexible membrane to limit the lubricant reservoir and/or the lubricant guide element. The membrane preferably manifests a higher elasticity than the other lubricant guide components of the internal combustion engine. For that reason, the membrane is preferably constructed of an elastic material or component, especially of a lubricant-resistant plastic. Alternatively, the membrane is constructed as an especially thin-walled component. The membrane can be housed with

lubricant on one side and ambient air on the other side or, as the case may be, in a closed storage volume and is preferably impacted with an inert gas.

In another version of the invention the dampening element manifests a storage volume to accept a compressible medium, especially to accept a quantity of gas and/or a foam. The storage volume is preferably separate from the lubrication circuit, but is constructed directly adjacent to it. For the separation, a flexible membrane is associated with the gas quantity or a largely closed separating layer with the foam, especially in the form of closed pores. In the process, the gas quantity or the foam manifests a higher compressibility than the lubricant.

In another variation of the invention, the dampening element manifests a storage volume to accept a rubber-elastic body. The rubber-elastic body possesses a higher compressibility than the lubricant and acts as an especially effective damper for the pressure pulsations that appear. The rubber-elastic body can preferably be constructed as a pipe guide element flowed through by the lubricant.

In another model of the invention, the dampening element manifests a storage volume to accept a mixture of the lubricant and a compressible medium, in particular a quantity of gas. The lubricant and the compressible medium are not separated in the storage volume, whereby the degree of intermixing is variable. The intermixing can almost be zero especially with an internal combustion engine that is not operating, i.e., a horizontal, free surface of the lubricant lies

opposite the compressible medium. There can also, however, be a suspension or a largely homogeneous mixture of the lubricant and the compressible medium. Another practical, especially relevant case is an expansion of the lubricant with a compressible medium in the form of air, whereby the degree of expansion preferably is so set, that the lubricating effect of the lubricant at the lubrication spots of the internal combustion machine is not disadvantageously affected.

In another variation of the invention, the elasticity of the membrane, the compressible medium and/or the rubber-elastic body can be changed or adjusted. That is done in particular by a change of pressure, temperature and/or the volume of the membrane, the compressible medium or the rubber-elastic body. To influence the temperature of the membrane, the compressible medium or the rubber-elastic body an electrical resistance heating, for example, can be used.

In another version of the invention, the quantity of the compressible medium accepted in the storage volume can be changed by the addition and/or removal of the compressible medium via an input opening. In the process, the elasticity of the dampening element can be adjusted by a change of the compressible medium in the dampening element. The degree of expansion can thus also be influenced in particular in a case involving expansion of the lubricant with the help of the compressible medium.

In another execution model of the invention, the dampening element is coupled across a line rising in a vertical direction to a lubricant guide element, so that a compressible medium is blocked in a storage volume inside a dampening element, in particular a gas quantity, with the

help of the lubricant. Air is preferably used as the compressible medium which can be housed in an especially simple manner in the sealed dampening element.

Other characteristics and combinations of characteristics can be seen in the description and the drawings. Concrete execution models of the invention are depicted in a simplified manner in the drawings and are explained in more detail in the following description. Shown are:

Figure 1: A sketch of the principle of a lubricant guide element with an initial variant of a dampening element of the invention;

Figure 2: A sketch of the principle of a lubricant guide element with a second variation of a dampening element of the invention;

Figure 3: A sketch of the principle of a lubricant guide element with a third variant of a dampening element of the invention;

Figure 4: A sketch of the principle of a lubricant guide element with a fourth version of a dampening element of the invention;

Figure 5: A sketch of the principle of a lubricant guide element with a fifth model of a dampening element of the invention;

Figure 6: A sketch of the principle of a lubricant guide element with a sixth variant of a dampening element of the invention;

Figure 7: A sketch of the principle of a lubricant guide element with a seventh variant of a dampening element of the invention;

Figure 8: A sketch of the principle of a lubricant guide element with an eighth version of a dampening element of the invention;

Figure 9: A sketch of the principle of a lubricant guide element with a ninth variant of a dampening element of the invention;

Figure 10: A sketch of the principle of a lubricant guide element with a tenth variant of a dampening element of the invention;

Figure 11: A sketch of the principle of a lubricant guide element with an eleventh version of a dampening element of the invention.

An internal combustion engine manifests in a known manner a lubrication circuit in which a lubricant pump moves a fluid lubricant, in particular a natural or synthetic motor oil, from a lubricant storage reservoir to lubrication spots of the internal combustion engine and, as the case may be, back to the storage reservoir. In the process, the lubricant flows in general through several lubrication guide elements on the one hand, as well as a housing of the internal combustion engine. The lubrication pump is thereby associated with a lubrication guide element in the shape of a suction pipe line through which the lubricant moves from the storage reservoir (e.g., oil pump) to a lubricant pump.

During the operation of an internal combustion engine, the lubricant pump is generally also powered across a transmission by a gear of the internal combustion engine, whereby a pulsating movement of the lubricant is caused by the operating principle of the lubricant pump (e.g. geared wheel pump). The resulting pressure pulsations cause a (mostly unwanted) sound production, transmission and radiation.

To offset the named pressure pulsations, a flexible dampening element is provided in the invention, which is associated with a lubrication guide element of the lubrication circuit.

An initial sketch of the principle of a lubrication guide element 1a is shown in Figure 1 with an initial execution model of a dampening element 2a of the invention. The lubricant guide element 1a is constructed as an almost vertically positioned suction line of a lubricant pump which is not shown in more detail. The dampening element 2a thereby manifests an abrupt expansion 3a of the line cross-section of the suction line to form a calmed area 4a. The calmed area includes a certain length of the suction line and ends with an abrupt narrowing 3a'. The dampening element 2a is filled completely with the lubricant, whereby dead water areas that are present form a calmed lubricant reservoir to dampen the pressure pulsations. The lubricant guide element 1a as well as the dampening element 2a can be manifested as a round or a non-round, rectangular cross-sectional area, whereby rectangular cross-sectional areas favor the dampening

of pressure pulsations in an advantageous manner. That also applies to the other execution models.

Figure 2 shows a second sketch of the principle of a lubrication guide element 1b with a second execution model of a dampening element 2b of the invention. The dampening element 2b is constructed as a type of bypass resonator, whereby this is connected with the lubricant guide element 1b across a bleed line 6 (resonator throat) running perpendicular to the lubricant guide element 1b and is completely filled with lubricant. An abrupt expansion 3b of the cross-section of the bleed line 6 is provided to form a calmed lubricant reservoir 4b.

Figure 3 shows a third sketch of the principle of a lubrication guide element 1c with a third execution model of a dampening element 2c of the invention. There is an abrupt expansion 3c of the cross-section of the bleed line 6 to form a calmed lubricant reservoir 4c. The dampening element according to Figure 3 differs from the version of Figure 2 only by the flexible, elastic membrane 5 on the wall of the dampening element lying opposite the bleed line 6. In particular, the inside of the membrane 5 is in contact with the lubricant. In the process, it thereby preferably manifests a higher elasticity than most other component elements of the lubricant circuit of the internal combustion engine, so that pressure pulsations can preferably be guided into the membrane area. The dampening element 2c is so positioned, that the outside of the membrane is surrounded by ambient air or another compressible medium. In a modified execution model, the membrane is likewise surrounded on the outside by lubricant which preferably can be done

by the dampening element being housed in the lubricant storage reservoir of the internal combustion engine.

Figure 4 shows a fourth sketch of the principle of a lubrication guide element 1d with a fourth execution model of a dampening element 2d of the invention. There is an abrupt expansion 3d of the cross-section of the bleed line 6 to form a calmed lubricant reservoir 4d. The dampening element 2d according to Figure 4 differs from the versions of Figures 2 and 3 by a storage volume 7 that is closed on all sides to accept a defined quantity of gas G. The storage volume 7 manifests a flexible, elastic membrane 8 and is otherwise constructed with a bowl or pot shape. Pressure pulsations are guided in an advantageous manner specifically across the membrane 8 into the storage volume 7. In a modified execution model, the storage volume 7 and/or the membrane 8 are constructed so as to be heated by means of electrical resistance heating to adjust the elasticity.

Figure 5 shows a fifth sketch of the principle of a lubrication guide element 1e with a fifth execution model of a dampening element 2e of the invention. An abrupt expansion 3e of the cross-section of the bleed line 6 is provided to form a calmed lubricant reservoir 4e. The dampening element 2e according to Figure 5 differs from that of Figure 2 and 3 by the membrane 9 which divides the lubricant reservoir 4e into two partial volumes preferably of the same size.

Figure 6 shows a sixth sketch of the principle of a lubrication guide element 1f with a sixth

execution model of a dampening element 2f of the invention. There is an abrupt expansion 3f of the cross-section of the bleed line 6 to form a calmed lubricant reservoir 4f. The dampening element 2f according to Figure 6 differs from the models of Figures 2 and 4 by a storage volume 10 to accept a rubber-elastic shaped body. The shaped body is constructed in a modified execution model to adjust the elasticity by means of electrical resistance heating.

Figure 7 shows a seventh sketch of the principle of a lubrication guide element 1g with a seventh execution model of a dampening element 2g of the invention. There is an abrupt expansion 3g of the cross-section of the lubricant guide element 1g to form a calmed area 4g. The calmed area 4g includes a certain long area of a suction line and ends with an abrupt narrowing 3g'. The dampening element 2g is completely filled with lubricant, whereby the dead water areas present form a calmed lubricant reservoir to dampen the pressure pulsations. Finally a rubber-elastic wall 11 is associated with the dampening element 2g which forms the boundary of the lubricant-guiding interior area. The dampening element 2g is thus designed as a type of normal line element, but compared to the other line elements it manifests an increased compressibility which is designed so that pressure pulsations – especially in the selected frequency ranges – are accepted well and are dampened. The rubber-elastic wall 11 is preferably stiffened with metal on the outside.

Figure 8 shows an eighth sketch of the principle of a lubrication guide element 1h with an eighth execution model of a dampening element 2h of the invention. As a difference to the seventh

execution model according to Figure 7 there is no expansion of the cross-section of the lubricant guide element; instead a lubricant-guiding, rubber-elastic, cylindrical-shaped part 12 is provided which is designed in such a compressible manner that pressure pulsations – especially in the selected frequency ranges – are accepted well and are dampened. The rubber-elastic, cylindrical-shaped part 12 is preferably stiffened or encased with metal on the exterior. The length and thickness of the shaped part are selected depending on the frequency range of the pressure pulsations to be dampened. In a modified execution model a dampening element according to Figure 8 substitutes a complete suction line of a lubricant pump.

Figure 9 shows a ninth sketch of the principle of a lubrication guide element 1j with a ninth execution model of a dampening element 2j of the invention. The dampening element 2j is constructed like a bypass resonator, whereby this is connected with the lubricant guide element 1j across a bleed line 6 (resonator throat) running perpendicular to the lubricant guide element 1j. An abrupt expansion 3j of the cross-section of the bleed line 6 is provided to form a calmed lubricant reservoir 4j. In addition, a branch boring 13 is positioned on the top of a vertical side of the dampening element 2j through which a compressible medium, preferably air, can be introduced or removed from the lubricant reservoir 4j. Thus the mass of the air in the reservoir can be varied by means of the branch boring 13, so that the elasticity of the dampening elements 2j can be adjusted. The lubricant and air are not separated in the lubricant reservoir 4j so that both can mix, whereby the degree of mixing is variable. The mixing can be almost zero for a

non-operating internal combustion engine, i.e., a free, horizontal surface 14 of the lubricant is exposed to the air. A strong expansion of the lubricant with the air can, however, be produced in the area of the lubricant reservoir 4j, whereby the entire reservoir 4j can be filled by the expanded mixture of the lubricant and air. The degree of expansion is preferably regulated so that the lubrication effect of the lubricant is not disadvantageously affected at the lubrication spots of the internal combustion engine. Thus, an optimal relationship between the dampening effect on the dampening element 2j and the lubrication effect at the lubrication spots of the internal combustion engine can be set by means of the degree of expansion. In addition, an especially high dampening effect against pressure pulsations in the lubricant can be obtained, when needed.

Figure 10 shows a tenth sketch of the principle of a lubrication guide element 1k with a tenth execution model of a dampening element 2k of the invention. The dampening element 2k is constructed as a type of bypass resonator, whereby this is connected with the lubricant guide element 1k across a bleed line 6 rising in a vertical direction running perpendicular to a lubricant guide element 1b. There is an abrupt expansion 3k of the cross-section of the bleed line 6 to form a calmed lubricant reservoir 4k. The lubricant reservoir 4k is only partially filled with the lubricant; the other part is filled with a compressible medium, preferably with air or with an inert gas which is confined above the fluid level 15 of the lubricant quasi in the lubricant reservoir 4k and can not be forced out of the reservoir. In a modified execution model, the

reservoir is completely filled, preferably with an inert gas.

Figure 11 shows an eleventh sketch of the principle of a lubrication guide element 1m with an eleventh execution model of a dampening element 2m of the invention. The dampening element 2m is constructed as a type of gas or air pillow and is placed on the base of the lubricant reservoir which is constructed in the shape of an oil sump (16). In particular, the dampening element 2m is coupled to the lubrication circuit in that it is positioned at a slight distance next to – preferably opposite – the intake suction opening of the lubricant guide element 1m. An elastic membrane 17 is provided on the side of the dampening element 2m facing the intake suction opening.

In all of the execution models depicted, a coupling of the compressible element (dampening element) to the lubrication circuit of a vehicle internal combustion engine is done in such a way that pressure pulsations are guided into the compressible element and are dampened there or can be guided out of the lubrication circuit. As a result, the sound radiation of the entire internal combustion engine is reduced in the invention.

The characteristics of the execution models of the device of the invention which were described as examples can be combined with each other in any desired manner, so that other advantageous properties and combination of properties can result.

Patent Claims

1. Internal combustion engine for a motor vehicle with a lubricant pump to transport a fluid, almost incompressible lubricant, especially a motor oil, and a lubricant guide element (1a – 1k) to guide to lubricant to the lubrication points of the internal combustion engine, thereby characterized by an elastic, flexible dampening element (2a – 2k) being associated with the lubricant guide element (1a – 1k) to accept pressure pulsations in the lubricant.

2. Internal combustion engine according to Claim 1, thereby characterized by the dampening element (2a – 2k) manifesting an abrupt expansion (3a – 3k) of a line cross-section, especially like a bypass resonator, to form a calmed lubricant reservoir (4a – 4k).

3. Internal combustion engine according to Claim 1 or 2, thereby characterized by the dampening element (2c) manifesting a flexible membrane (5) to limit the lubricant reservoir (4c) and/or the lubricant guide element.

4. Internal combustion engine according to one of the previous claims, thereby characterized by the dampening element (2d) manifesting a storage volume (7) to accept a compressible medium, especially to accept a quantity of gas (G) and/or a foam.

5. Internal combustion engine according to one of the previous claims, thereby characterized by the dampening element (2f) manifesting a storage volume to accept a rubber-elastic body (10).

6. Internal combustion engine according to one of the previous claims, thereby characterized by the dampening element (2j) manifesting a storage volume (4j) to accept a mixture of a lubricant and a compressible medium, especially a quantity of gas.

7. Internal combustion engine according to one of the previous claims, thereby characterized by the elasticity of the membrane (5, 8, 9) of the compressible medium (G) and/or the rubber/elastic body (10) being able to change or adjust.

8. Internal combustion engine according to one of Claims 4, 6 or 7, thereby characterized by the quantity of the compressible medium accepted in the storage volume (4j) being changed by the addition and/or removal of the compressible medium across a bleed line (13).

9. Internal combustion engine according to one of the previous claims, thereby characterized by the dampening element (2k) being coupled to the lubricant guide element (1k) across a line (16) rising in a vertical direction, so that a compressible medium, especially a quantity of gas, is confined in a storage volume (4k) within the dampening element (2k) with the help of the lubricant.

Summary

This invention involves an internal combustion engine for a motor vehicle with a lubricant pump to transport a fluid, almost incompressible lubricant, especially a motor oil, as well as a lubricant guide element (1b) to guide the lubricant to the lubrication points of the internal combustion engine.

In the internal combustion engine of the invention an elastic, flexible dampening element (2b) to accept pressure pulsations in the lubricant is associated with the lubricant guide element (1b). A dampening element (2b), for example, can have a bypass resonator with a calmed lubricant reservoir (4b).

Use, for example, is in passenger motor vehicles.

Figure 2